

3RD INTERNATIONAL RED SEA EMERGENCY MEDICINE CONFERENCE



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King Faisal Specialist Hospital & Research Centre
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الجمعية السعودية لطب الطوارئ
Saudi Society of Emergency Medicine

Mechanical Ventilation in Status Asthmaticus

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PEDIATRIC CRITICAL CARE MEDICINE

No Disclosure

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Headline

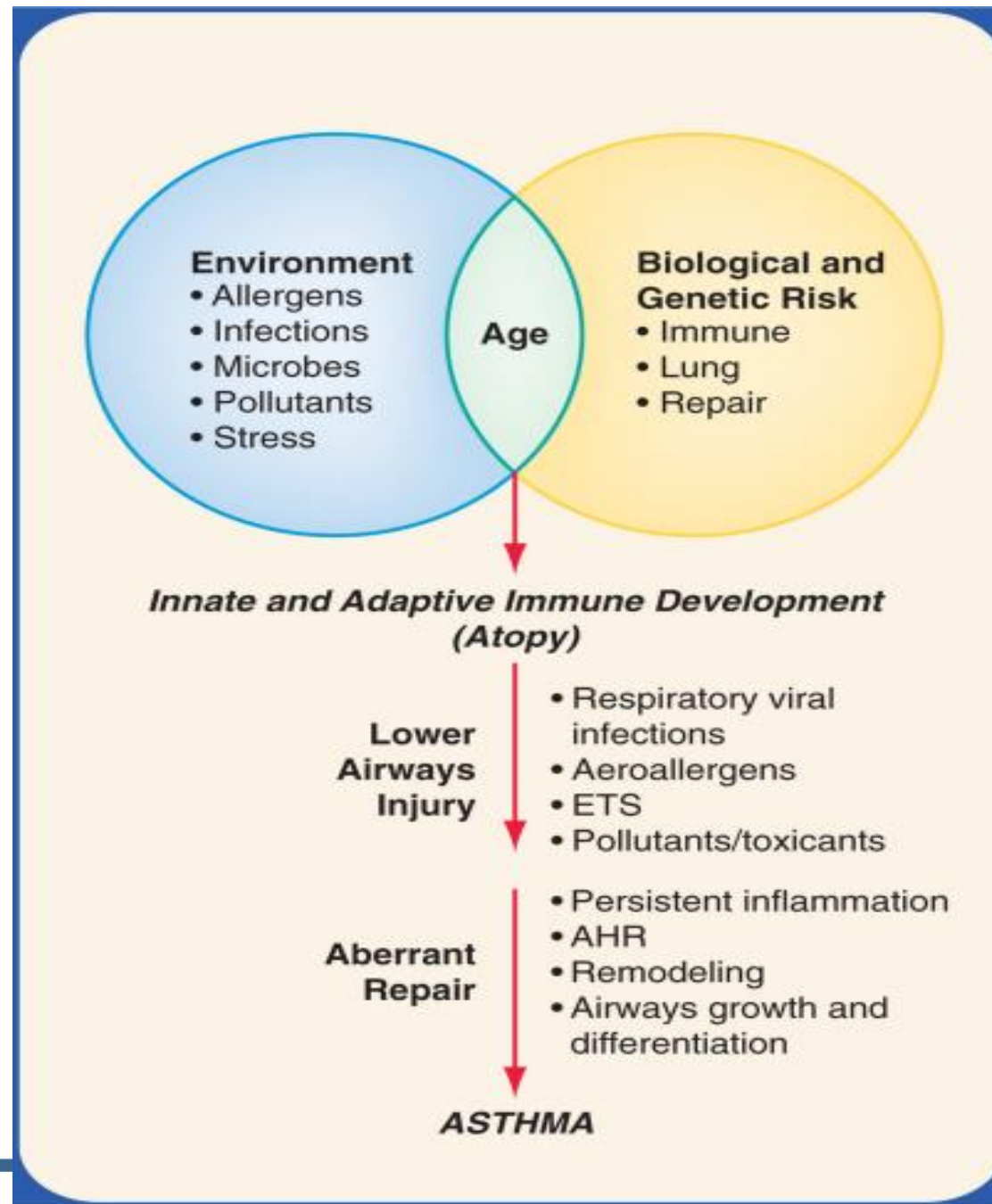
- REVIEW OF ASTHMA PATHOLOGY
- INDICATIONS FOR INTUBATION
- VENTILATION STRATEGY
- AUTO PEEP
- PERMISSIVE HYPERCABNIA
- ADJUVANT THERAPIES

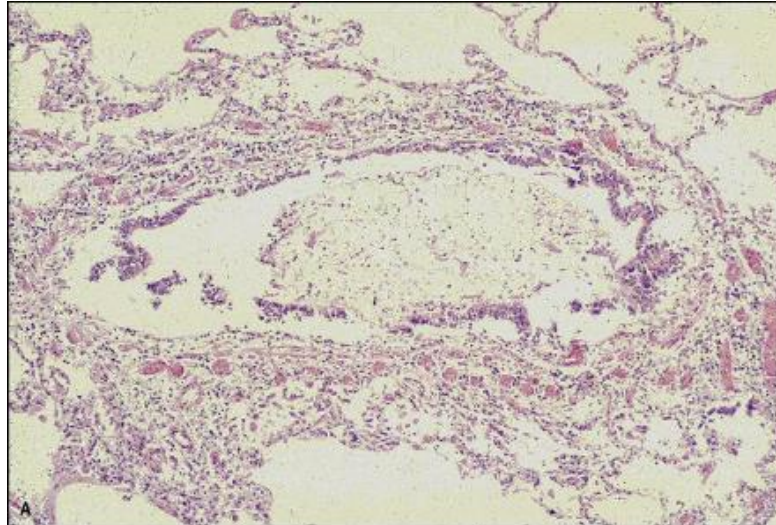


Case presentation

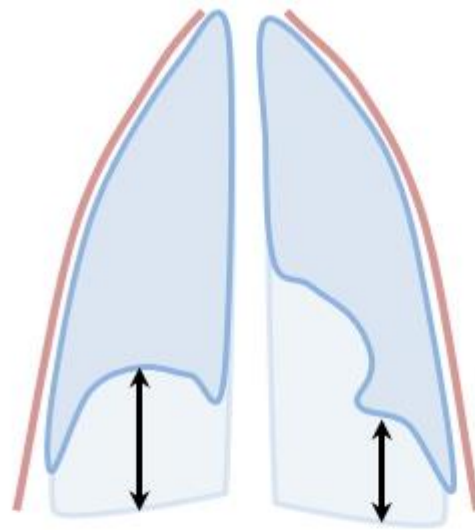
- 4 years old boy with status asthmaticus
- Intubated at an outside hospital.
- Blood gas: 7.16, 84, 75, -9
- Inhaled isoflurane was unsuccessful
- Currently patient is on a TV 6.5ml/kg, PEEP 6, FiO2 40% and RR 55



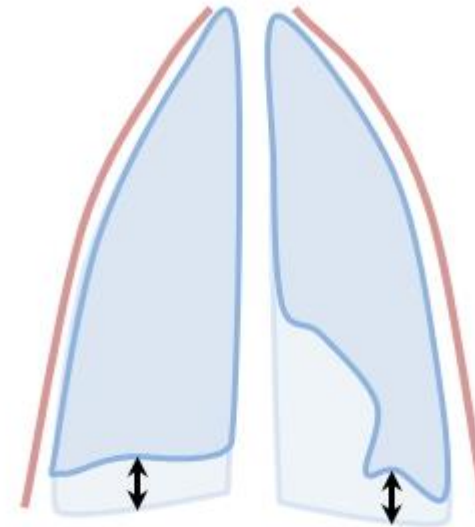




Physiological consequences of bronchospasm



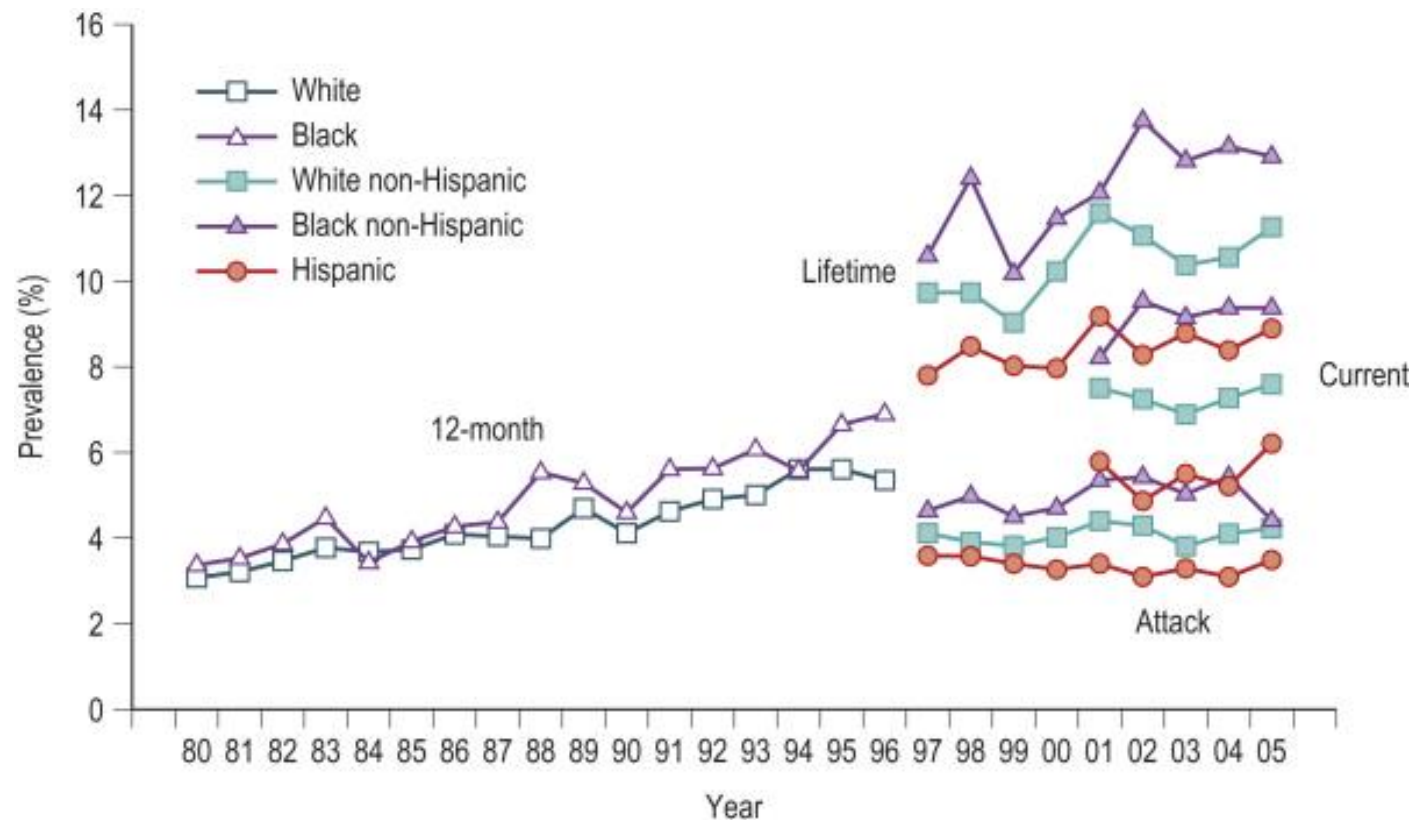
Normal diaphragmatic excursion



Diaphragmatic excursion in a hyperinflated asthmatic chest



Prevalence

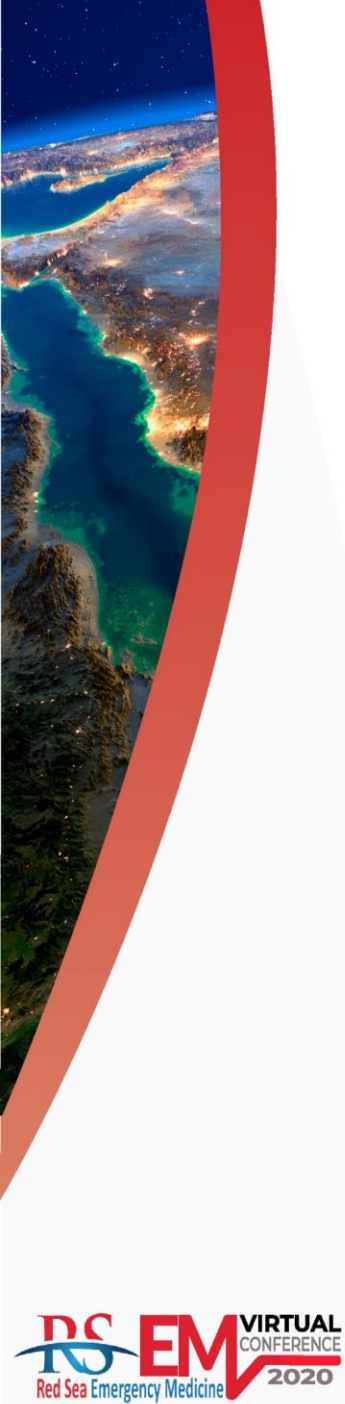


Akinbami LJ. Asthma prevalence, health care use and mortality: United States, 2003–05. 12-12-0006. Hyattsville, MD: National Center for Health Statistics; 2006

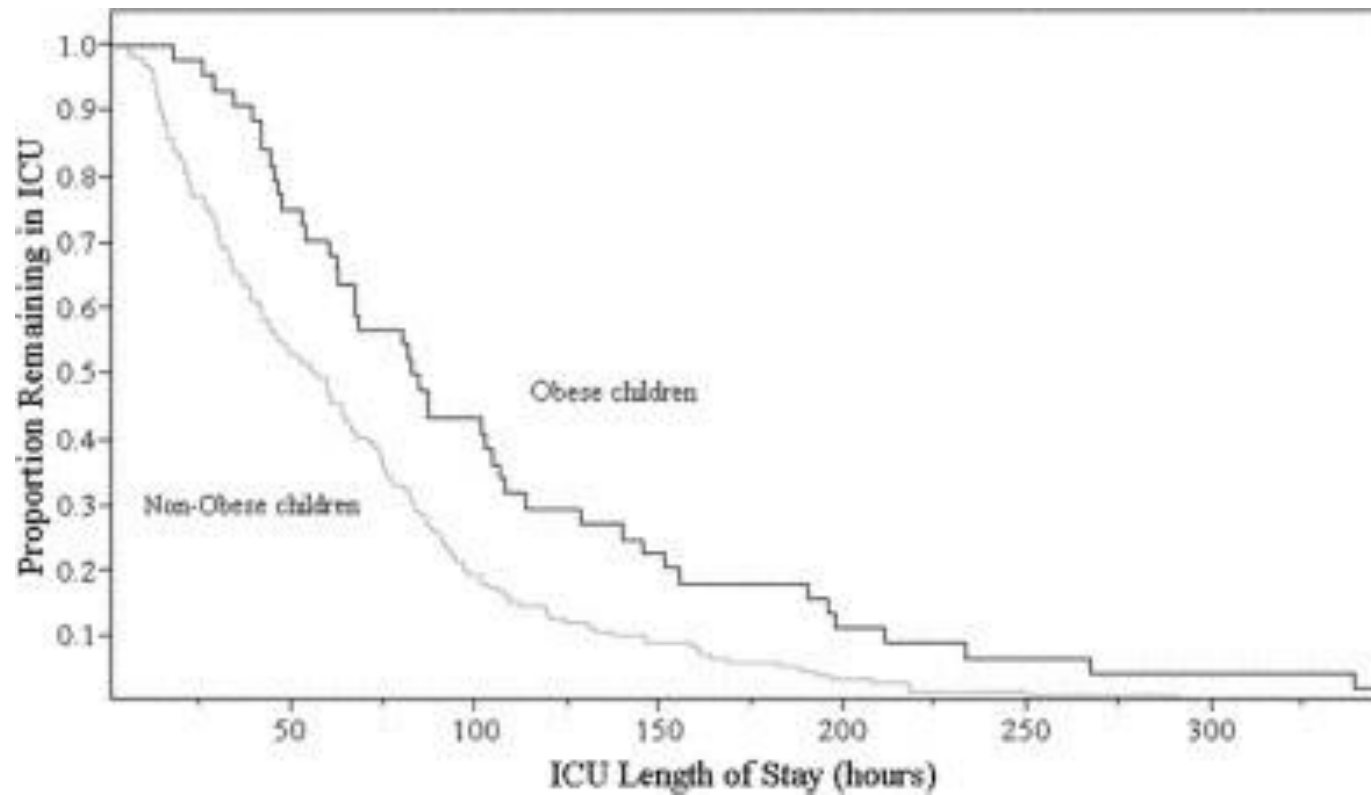
Risk factors of Status Asthmaticus

- History of previous asthma exacerbation with:
 - Severe, rapid progression of symptoms
 - Respiratory failure requiring endotracheal intubation or ventilatory support
 - Seizures or loss of consciousness
 - PICU admission
- Denial or failure to perceive the severity of illness
- Non-compliance with controller medications or asthma care plan
- Lack of social supports or safety network (e.g., dysfunctional family, poverty)
- Associated psychiatric disorder: depression..
- African American and Hispanic children

[J Pediatr Pharmacol Ther.](#) 2013 Apr-Jun; 18(2): 88–104.



Status Asthmaticus and Obesity



Carroll et al Pediatric Critical Care Medicine - Volume 7, Issue 6 November 2006

Treatment: Pre-intubation

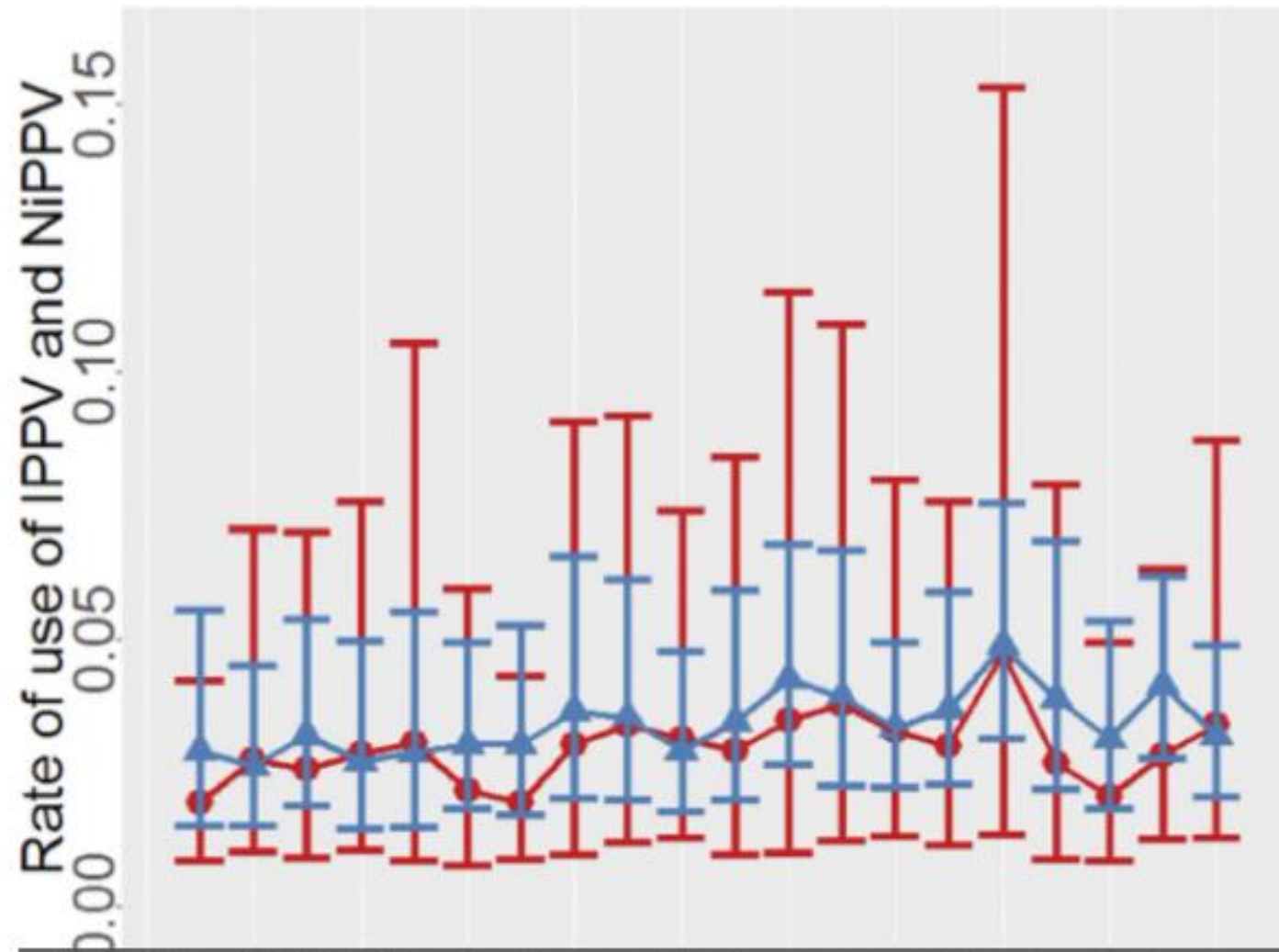
- O2
- Corticosteroids.
- Bronchodilator therapy:
 1. Inhaled: albuterol, atrovent, iNO
 2. IV: MgSo4, terbutaline, aminophylline, ketamine
 3. BOTH (IV/inhaled)WATCH FOR SIDE EFFECTS!!



BiPAP Vs Intubation ???

- Retrospective cohort study in 46 pediatric hospitals from 2010 to 2015.
- 90,777 children were eligible for analysis.
- (3.1%) received IPPV; (3.3%) received NiPPV; (93.6%) received medications without PPV.
- Over 5yrs, There was no change in IPPV and NiPPV use.
- Children who received IPPV were younger than those who received NiPPV ($p < 0.0001$), and had higher risk of mortality ($p < 0.0001$).
- No significant differences in PICU admission and length of stay between IPPV and NiPPV.

Variation in the Use of Mechanical Ventilation and Medications for Pediatric Status Asthmaticus
Heather Kelker, Rachel Stanley, Julie C. Leonard, Daniel Cohen, David Kline, Songzhu Zhao and Kristin Stukus
Pediatrics May 2018, 142



Rates of IPPV and NiPPV Use Over Time This is a graphical representation of invasive positive pressure ventilation (IPPV) and non-invasive positive pressure ventilation (NiPPV) rates of use over time, expressed as a percentage of total asthma hospital admissions by quarter, by year. Points represent the rate and bars represent the 95% confidence intervals.

Bilevel positive airway pressure

- Nasal BiPAP with a mask that covers only the nose
- Subjects tolerating BiPAP were 73 (88%) of 83.
- No adverse outcomes.

Beers SL - *Am J Emerg Med* - 01-JAN-2011; 25(1): 6-9





Limitations

- Requires patient cooperation.
- Impairs ability to clear secretions.
- Impairs ability to deliver Neb. Medications.
- Does not provide definitive control of the airway.
- Gastric distension / increased risk of aspiration.
- May cause heightened sense of air hunger upon initiation.
- Patients may feel claustrophobic.

ALTERNATIVE THERAPIES FOR POSSIBLE PREVENTION OF INTUBATION

- Heliox
- Ketamine
- Glucagon
- Leukotriene inhibitors
- Nebulized clonidine
- Nitroglycerin
- Nebulized calcium channel blockers
- Nebulized lidocaine
- External chest compression



Stepwise approach

- Nebulized albuterol/ Heliox/ BiPAP
- Early sedation
- The decision to intubate a patient should not be delayed until respiratory failure is imminent .
- Before intubation, consider a fluid bolus!!



CONSENSUS INDICATORS FOR INTUBATION

- Clinical Cardiac arrest
- Respiratory arrest
- Altered sensorium
- Progressive exhaustion
- Silent chest
- Severe hypoxemia with maximal oxygen delivery
- Failure to reverse severe respiratory acidosis despite intensive therapy



Site of original care affects treatment pathway!

- Children who originally sought medical care at a community hospital ED were significantly more likely (odds ratio 3.7; 95% confidence interval 1.5, 9.0) to have been intubated and mechanically ventilated than those who originally sought care at a children's hospital ED

Carroll et al, Pediatric Critical Care Medicine - Volume 8, Issue 2 (March 2007)

Ventilation strategy

- Controlled hypoventilation .
- Volume control ventilation .
- Adequate time for complete exhalation.
- Permissive hypercarnia.



Permissive Hypercapnia

- Systemic Physiologic Effects
 1. Respiratory :air hunger, anxiety, fatigue
 2. Cardiovascular :increased C.O, tachycardia, systemic and pulmonary hypertension, myocardial depression and dysrhythmias
 3. Neurologic : cerebral hemorrhage and herniation,
 4. Metabolic : catecholamines/ corticosteroids release, i tissue O2 unloading, decreased effect of vasopressors
- Anti-Inflammatory Action
 1. Attenuate free radical production
 2. Less tumor necrosis factor and (IL)-1 production

Permissive Hypercapnia

- Contraindications:
 1. Increased ICP.
 2. Poor myocardial function .
 3. Coexistent metabolic acidosis .
- Pharmacologic buffering.
- THAM needs a kidney.
- HCO₃ needs a lung.

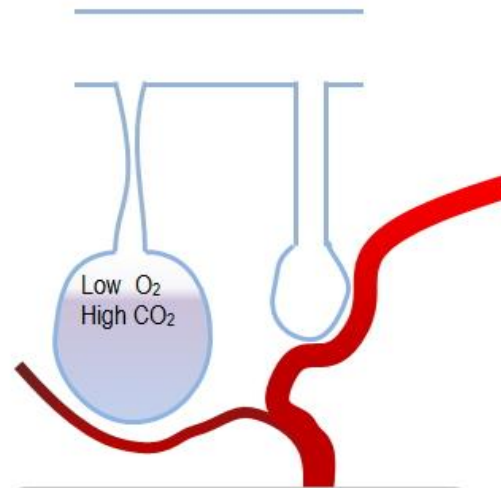


Mechanical ventilation of the intubated asthmatic

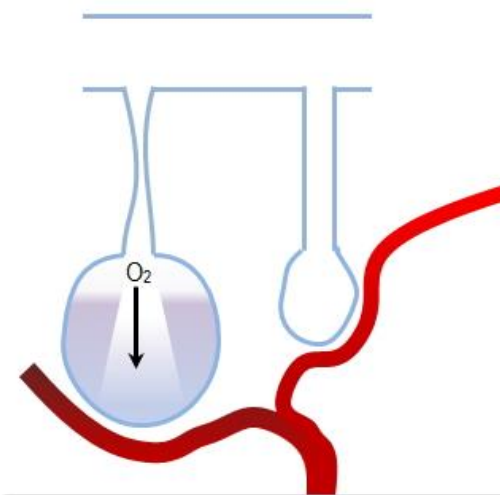
- **Use the largest tube possible.**
- **Use lowest FiO_2 to achieve SpO_2 of 90-92%**
- **Use a small tidal volume, 5-7ml/kg**
- **Use a slow respiratory rate, 10-15 breaths per minute (or even less!)**
- **Use a long expiratory time, with I:E ratio 1:3 or 1:4**



V/Q mismatching



Hypoxic vasoconstriction diverts blood from those lung units most affected by bronchospastic ventilation failure, thereby maintaining a good V/Q match

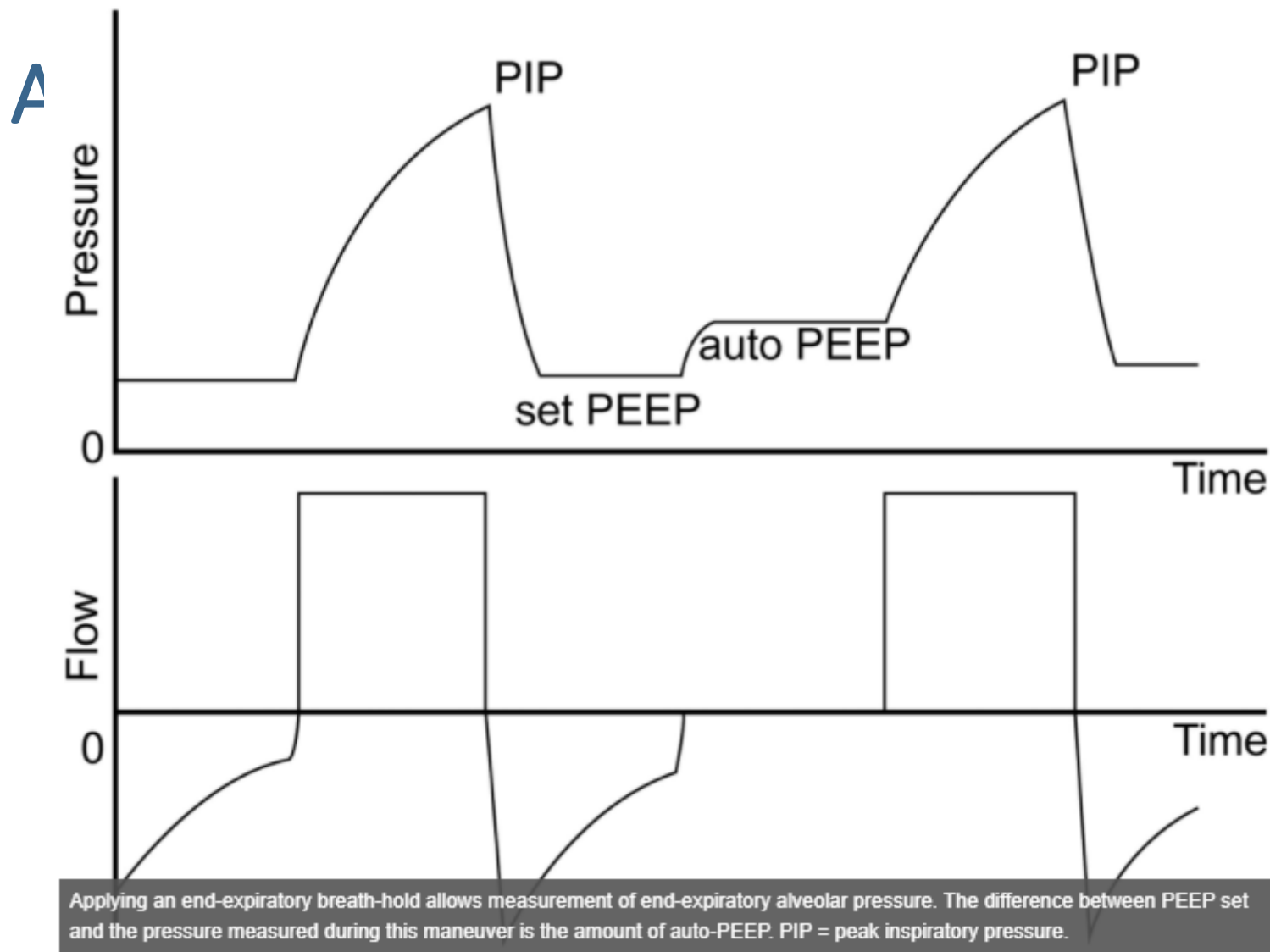


Hyperoxia contributes oxygen to poorly ventilated bronchospastic regions, and degrades the V/Q matching by "stealing" blood from well ventilated regions

Back to Our case

- FiO2 : lowest possible!!
- Respiratory rate (55→12)
- Tidal volume (6.5 ml/kg→9ml/kg)
- The peak and plateau pressures monitoring.
- Inspiratory time, I:E(1:4)
- PEEP (low Vs High) 6→10 cm H2O

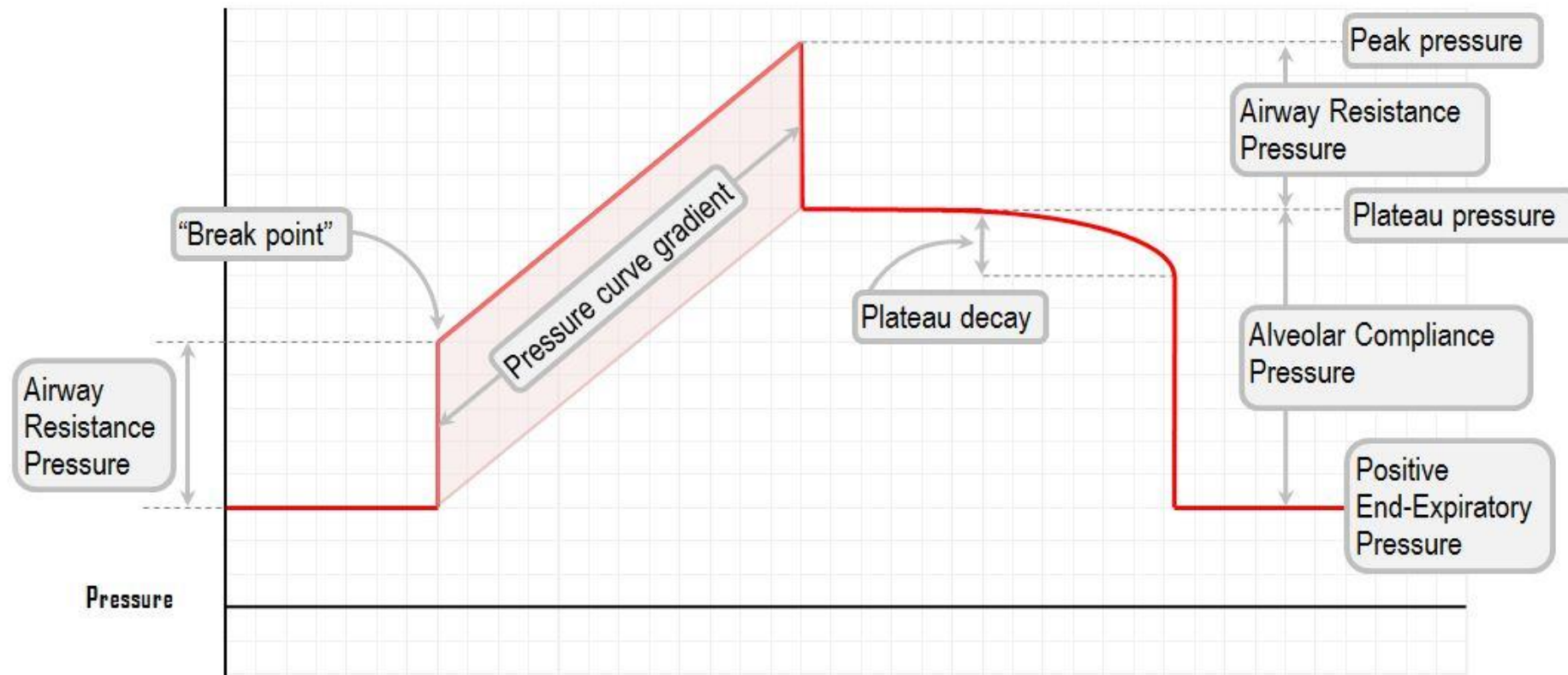


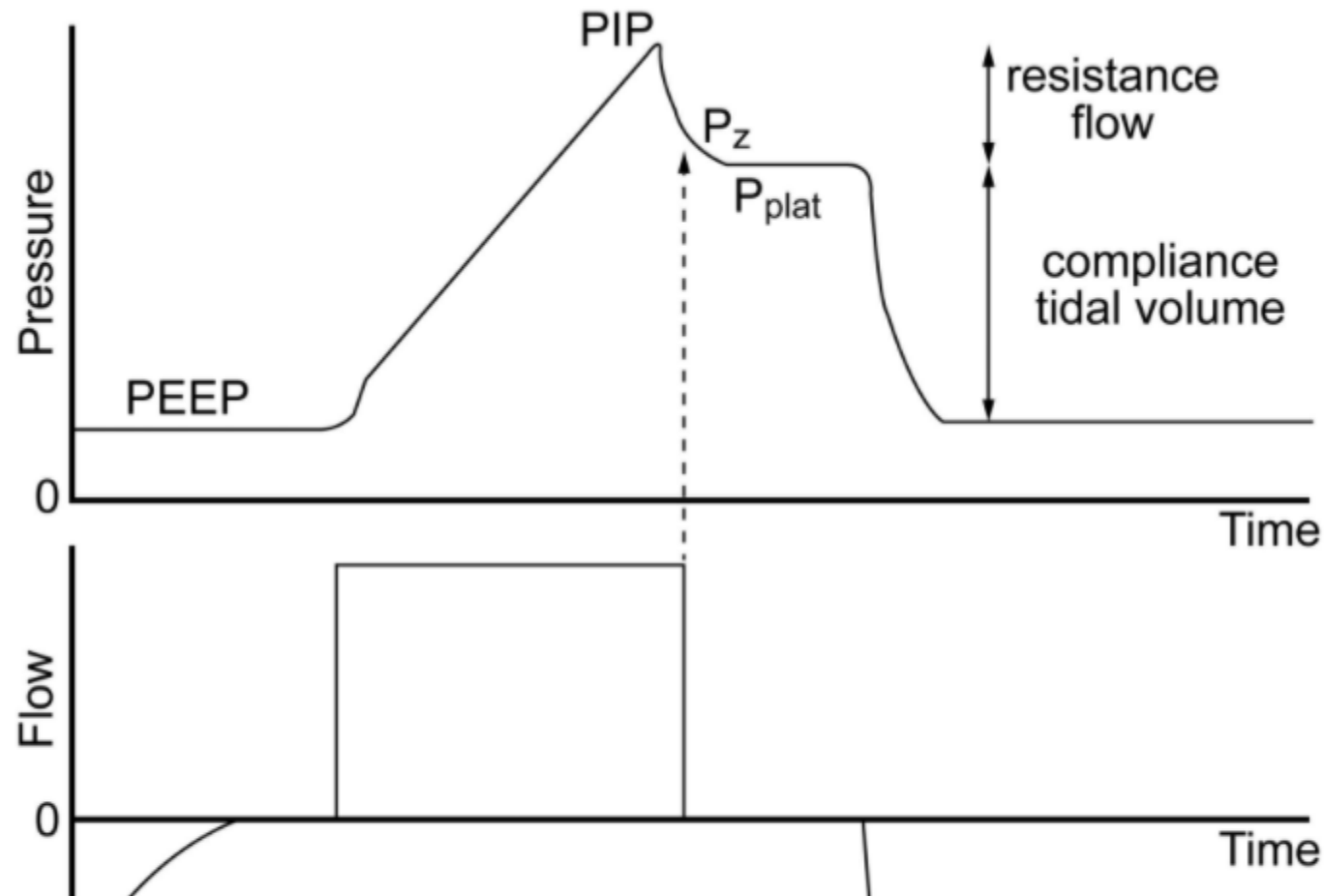


Respiratory Mechanics in Mechanically Ventilated Patients Dean R Hess
 Respiratory Care November 2014, 59 (11) 1773-1794; DOI:
<https://doi.org/10.4187/respcare.03410>

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Peak-Pause !





Airway pressure and flow waveforms during constant flow volume control ventilation, illustrating the effect of an end-inspiratory breath-hold. With a period of no flow, the pressure equilibrates to the plateau pressure (P_{plat}). P_{plat} represents the peak alveolar pressure. The difference between P_z and P_{plat} is due to time constant inhomogeneity within the lungs. The difference between the peak inspiratory pressure (PIP) and P_{plat} is determined by resistance and flow. The difference between P_{plat} and PEEP is determined by tidal volume and respiratory system compliance. P_z = pressure at zero flow.

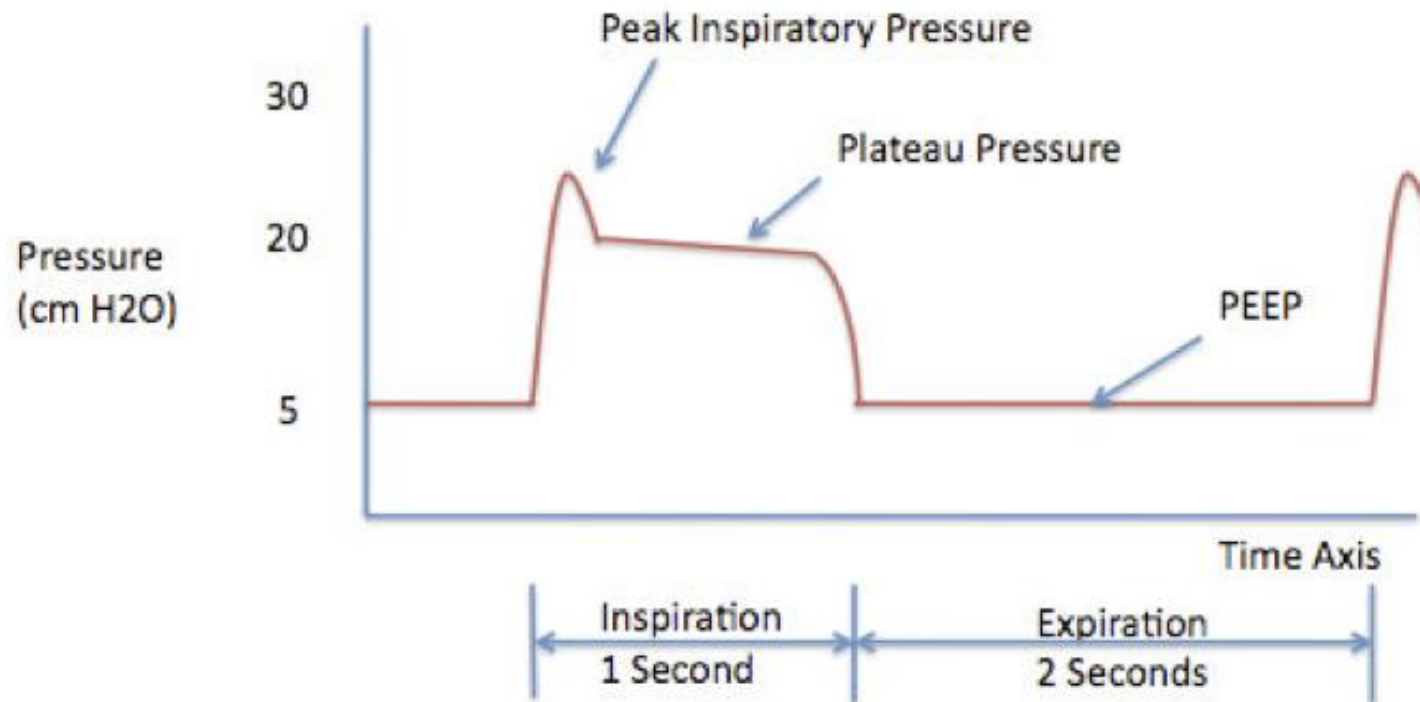
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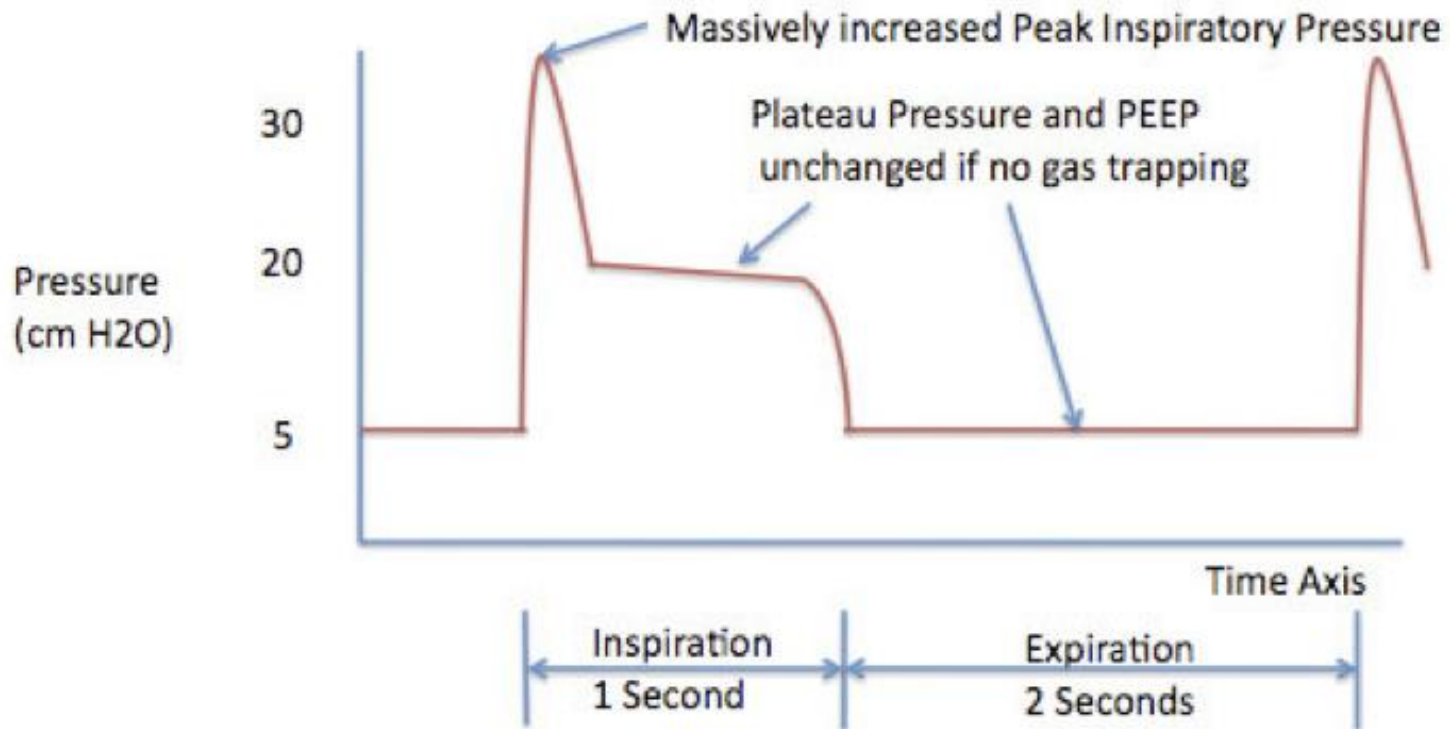
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Normal Pressure Time Curve

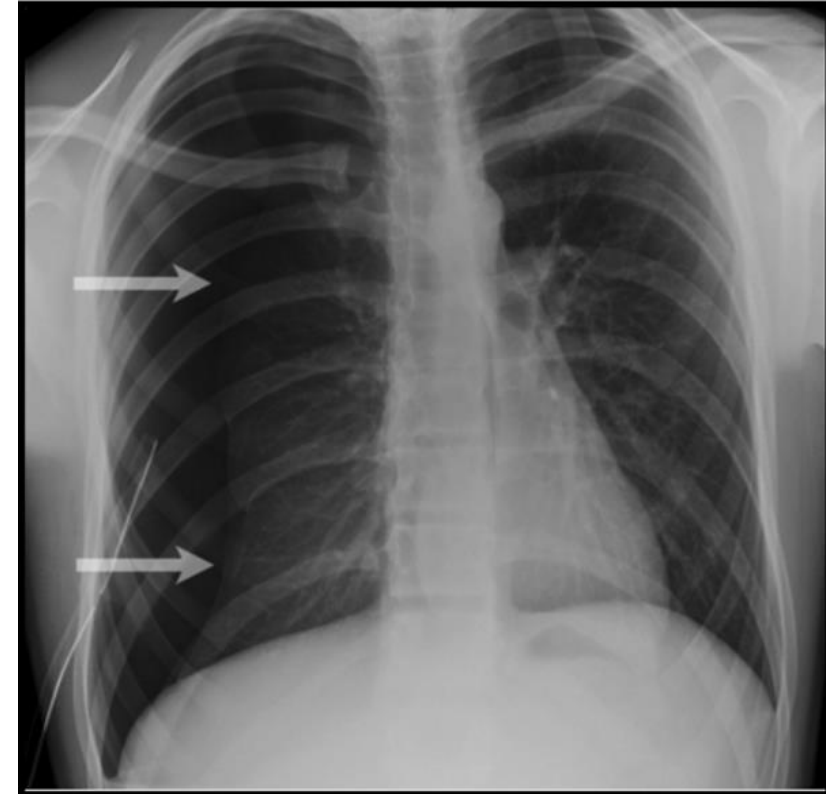


Acute Severe Asthma



Watch for Pneumo!

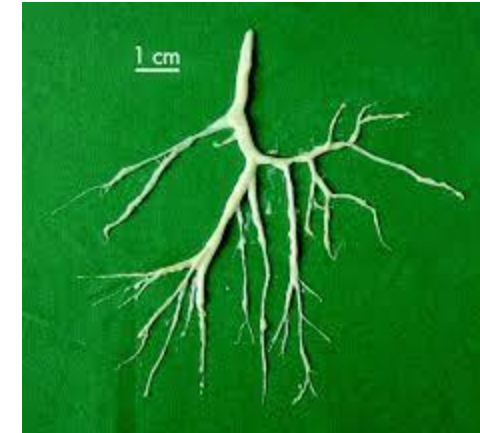
- Hypoxemia
- Hypotension
- Neck emphysema
- Muffled heart sounds
- Changes in chest auscultation.



- 
- Adequate venous access.
 - Isoflorane (stone-age Vs Cadillac Vents)
 - PEEP to match Auto.
 - Monitor auto PEEP /Peak-pause
 - PRVC.
 - Bronch if needed.
 - VA ECMO if needed.

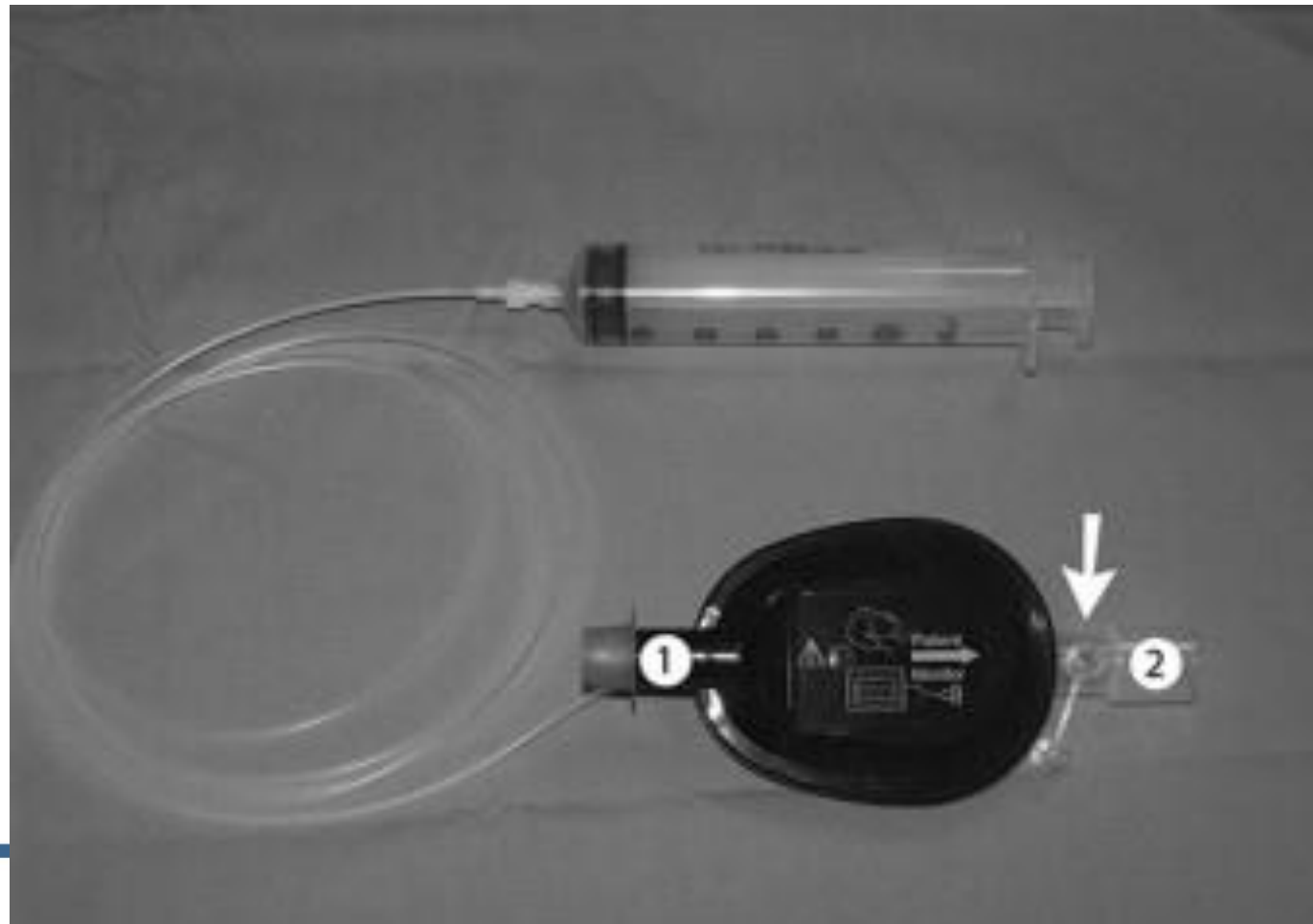
Adjuvant therapies

- Bronchoscopy
- Singulair
- 3%NS ?
- HCO3 nebs ?
- Lidocaine nebs ?

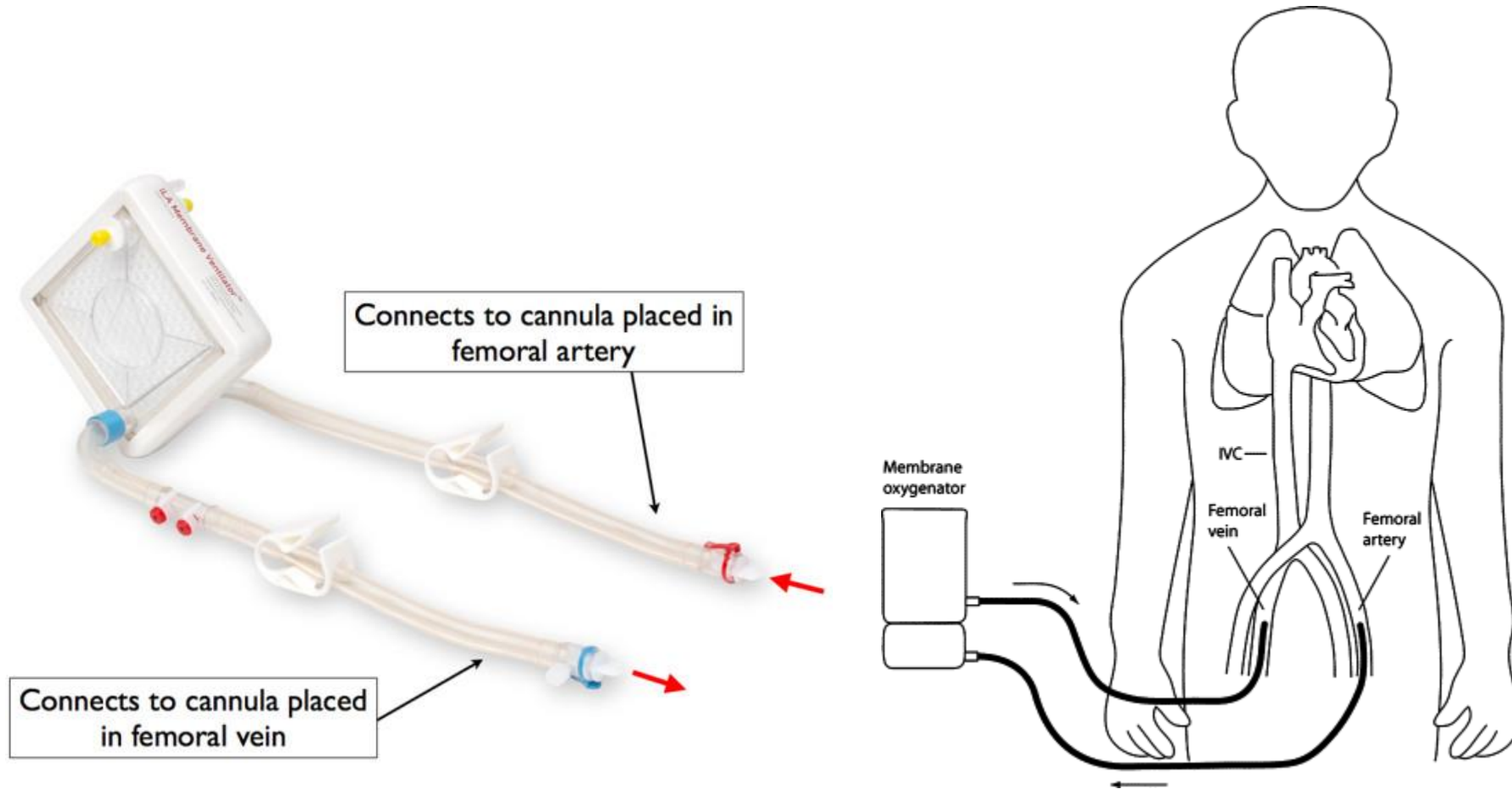


Anaesthetic Conserving Device

- Increase in the dead space



Pumpless arteriovenous carbon dioxide removal



Conrad SA, Green R Critical Care Medicine - Volume 35, Issue 11 (November 2007)

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